REMARKS

Applicants thank the Examiner for the careful review of this application. Please reconsider the application in view of the above amendments and the following remarks.

I. Disposition of Claims

Claims 1-3 and 5 are pending in the application. Claims 1-3 and 5 stand rejected under 35 U.S.C. § 103.

Claims 1 and 5 have been amended to specify that the permeate flow rates are at least 0.7 $m^3/m^2 \cdot day$ and 0.8 $m^3/m^2 \cdot day$, respectively. The amendments are fully supported by the original specification. See, for example, the descriptions located on page 3, lines 13-15, and example 4.

II. Rejections under 35 U.S.C. § 103

The present invention, as exemplified by the amended claim 1, relates to a composite reverse osmosis membrane comprising a porous support, a polyamide skin layer formed on the support, wherein the contact angle between the polyamide skin layer surface and water is no more than 45°, the sodium chloride rejection is at least 98% and the permeate flow rate is at least 0.7 $m^3/m^2 \cdot day$ when evaluated by using feed water that has pH 6.5, 0.05 weight percent salt (sodium chloride), and an operation pressure of 5 kgf/cm^2 at a temperature of 25° C.

While many polyamide reverse osmosis membranes are commercially available, the goal of the industry continues to be the development of membranes that have better flux and salt rejection characteristics. Advantageously, membranes of the present invention, as recited in the amended claim 1, have high salt rejection rates (≥98%), reasonable hydrophilicity (a water contact angle ≤ 45°), and high flux (≥ 0.7 $m^3/m^2 day$ under the test conditions of the present invention).

A. The Examiner rejected claims 1-3 and 5 under 35 U.S.C. § 103, as being obvious over Tomaschke et al. (USPN 5,254,261), Rice et al. (USPN 6,132,804), Hirose et al. (JP 10-33958), or Hirose et al. (JP 10-33959) in view of Hashino et al. (USPN 4,208,508) and Hancock et al. (USPN 5,700,903). To the extent this rejection applies to the amended claims, it is respectfully traversed.

Tomaschke et al. and Rice disclose polyamide reverse osmosis membranes. However, these membranes do not have the same flux and salt rejection characteristics as recited in the amended claims.

Among the membranes disclosed by Tomaschke et al. that have at least 98% salt rejection characteristics, the highest flux disclosed (Example 9) is 47.8 gfd (= 1.95 $m^3/m^2 \cdot day$) under the disclosed test conditions: 2000 ppm NaCl and 225 psi (= 15.8 kgf/cm^2).

This flux is equivalent to 0.62 $m^3/m^2 \cdot day$ under the test conditions of the present invention (0.05% NaCl and 5.0 kgf/cm^2): 1.95 $m^3/m^2 \cdot day \times (5.0 - 0.4) / (15.8 - 1.6) =$ 0.62 $m^3/m^2 \cdot day$, where 0.4 (kgf/cm^2) and 1.6 (kgf/cm^2) represent the osmotic pressures of 0.05% NaCl and 2000 ppm NaCl, respectively. Therefore, the membrane with the best flux characteristics disclosed by Tomaschke et al. has a permeate flow rate (flux) lower than the lower bound (0.7 $m^3/m^2 \cdot day$) of the present invention.

Similarly, among the membranes disclosed by Rice, the one having the best flux and salt rejection (>98%) characteristics is shown in Table 4. This membrane has a flux of 50 gfd (= 2.0 $m^3/m^2 \cdot day$) under the disclosed test condition: 2000 ppm NaCl and 220 psi (= 15.5 kgf/cm^2). This flux is equivalent to 0.66 $m^3/m^2 \cdot day$ under the test conditions of the present invention: 2.0 $m^3/m^2 \cdot day \times (5.0 - 0.4) / (15.5 - 1.6) = 0.66$ $m^3/m^2 \cdot day$. Thus, the membranes of Rice also have permeate flow rates lower than the lower bound (0.7 $m^3/m^2 \cdot day$) of the present invention.

Hirose et al. (JP 10-33958) or Hirose et al. (JP 10-33959) disclose "negative charge-bearing" crosslinked polyamide membranes for removal of "positively charged" organic molecules (i.e., cationic organic substances and/or amphoteric organic

substances). These membranes are different from the reverse osmosis membrane of the present invention.

Furthermore, the membrane with the best permeate flow rate disclosed by the two cited Hirose documents is the membrane of Example 1 in both Hirose references. This membrane has a flux of 2.1 $m^3/m^2 \cdot day$ under the conditions of 1500 ppm NaCl and 15.0 kgf/cm^2. This flux is equivalent to 0.69 $m^3/m^2 \cdot day$ under the test conditions of the present invention: $2.1\ m^3/m^2 \cdot day \times (5.0 - 0.4) / (15.0 - 1.2) = 0.69\ m^3/m^2 \cdot day$. Thus, the membranes of Hirose et al. also have permeate flow rates lower than the lower bound (0.7 $m^3/m^2 \cdot day$) of the present invention.

Hashino et al. discloses semipermeable membranes, which are distinctly different from reverse osmosis membranes. The semipermeable membranes disclosed by Hashino et al. have pore diameters of about 10Å to about 0.5 μ. (column 4, lines 25-34). These semipermeable membranes are not suitable for the removal of Na^+ and Cl^-, which have diameters of 1.2 Å and 1.7 Å, respectively. Thus, Hashino et al. concerns a non-analogous art. Furthermore, although Hashino et al. discloses a correlation between semipermeable membranes and water contact angles, it does not teach or suggest what is missing in Tomaschke et al., Rice, and Hirose et al., i.e., reverse osmosis membranes with a flux of at least 0.7 $m^3/m^2 \cdot day$.

Hancock et al. discloses membranes formed of poly(ethyleneoxy) block copolymers, which are distinctly different from the reverse osmosis membranes of the present invention. More specifically, the Hancock membranes are produced by dissolving pre-formed poly(ethyleneoxy) polymer in a solvent, coating the resultant solution on the substrate, and allowing the solution to coagulate. This process cannot produce thin layers and, moreover, the pores thus formed have much lager diameters than those on reverse osmosis membranes. The membranes of Hancock et al. are useful only for the removal of molecules having molecular weights of several tens of thousands. In contrast, the present invention uses interfacial polymerization to create membranes that are capable of high flux and efficient salt rejection. Thus, Hancock et al. concerns a non-analogous art. Furthermore, although Hancock et al. discloses water contact angles, it

does not teach or suggests what is missing in Tomaschke et al., Rice, and Hirose et al., i.e., reverse osmosis membranes with a flux of at least 0.7 $m^3/m^2 \cdot day$.

For the above reasons, Tomaschke et al., Rice, Hirose et al., Hashino et al., and Hancock et al., either considered individually or in combination, cannot render the present invention as recited in claim 1 obvious. Claims 2-5 depend from claim 1 and should be allowable for at least the same reasons.

B. The Examiner rejected claims 1-3 under 35 U.S.C. § 103, as being obvious over Cadotte et al. (USPN 4,888,116) in view of Hashino et al. (USPN 4,208,508) and Hancock et al. (USPN 5,700,903). To the extent this rejection applies to the amended claims, it is respectfully traversed.

Among the membranes disclosed by Cadotte et al., the one having the best flux and salt rejection (>98%) characteristics is shown in Example 1. This membrane has a flux of 27 gfd (= 1.1 $m^3/m^2 \cdot day$) under their test condition: 2000 ppm NaCl and 200 psi (= 14.1 kgf/cm^2). This flux is equivalent to 0.41 $m^3/m^2 \cdot day$ under the test conditions of the present invention: $1.1\ m^3/m^2 \cdot day \times (5.0 - 0.4) / (14.1 - 1.6) = 0.41\ m^3/m^2 \cdot day$. Thus, the membranes of Cadotte et al. also have permeate flow rates that are lower than the lower bound (0.7 $m^3/m^2 \cdot day$) of the present invention.

As stated above, Hashino et al. and Hancock et al. concern non-analogous art and do not disclose reverse osmosis membranes having a flux of at least 0.7 $m^3/m^2 \cdot day$. Therefore, Cadotte et al., Hashino et al., and Hancock et al., either considered individually or in combination, cannot rendered claim 1 obvious. Claim 2 and 3 depend from claim 1 and should be patentable for at least the same reasons.

III. Conclusion

Claims 1-3 and 5 have been shown to be allowable over the prior art. The amendments are believed to require no further prior art search. Applicant believes that this paper is responsive to each and every ground of rejection cited by the Examiner in

the Action dated June 4, 2002, and respectfully requests favorable action in the form of a Notice of Allowance.

Please apply any charges not covered, or any credits, to Deposit Account 50-0591 (Reference Number 04558.039001).

Respectfully submitted,

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Appendix A: Marked-Up Version f Claims

1. (Three Times Amended) A composite reverse osmosis membrane comprising:

   a porous support; and

   a polyamide skin layer formed on the porous support, wherein **[the]** **a** contact angle between **a surface of** the polyamide skin layer **[surface]** and water is no more than 45°, sodium chloride rejection is at least 98%, and **[the]** **a** permeate flow rate is at least **[0.5]** **0.7** m^3/m^2day when evaluated by using feed water which has pH 6.5, 0.05 weight % of salt, an operation pressure of 5kgf/cm^2 and a temperature of 25°C.

5. (Twice Amended) The composite reverse membrane according to claim 1, wherein the sodium chloride rejection is at least 98% and the **[water permeability]** **permeate flow rate** is at least **[0.6]** **0.8** m^3/m^2day **[when evaluated by using feed water which has pH 6.5, 0.05 weight % of salt, an operation pressure of 5kgf/cm^2 and a temperature of 25°C]**.